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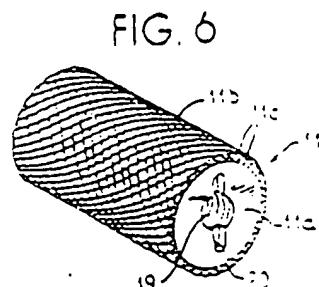
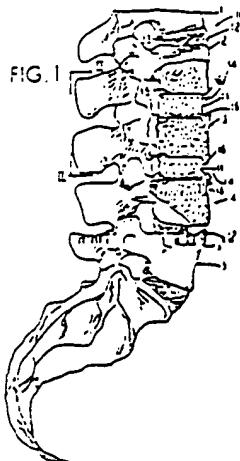
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(52) Surgical prosthetic implant.

(57) Prosthetic plug implants (11,31-34,111) forming side-by-side transverse struts between adjacent vertebrae having roughened surfaces (11b,31b,32b,34d,122) receiving bone ingrowth to fuse the plugs on prepared surface sites (15,115) on opposed faces of adjacent vertebrae and have end faces (11a,31a,34a,111c) with tool receiving recesses (19,111d) securing the plug on a tool (24,120) for insertion on the prepared sites of the vertebrae and for removing the tool from the plug without disturbing its position on the sites. These sites can be prepared by feeding a drill (21) through a guide (22) fixed to posterior or anterior sides of adjacent vertebrae to form the prepared sites including cortex bone (18,118) in the opposed faces of the adjacent vertebrae and terminating the drilling in advance of the opposite sides of the vertebrae (16,116). Gauge blocks (119) may be used to stretch collapsed disc tissue (112a) between the vertebrae to reclaim normal disc space between the vertebrae. A preferred implant (111) is rectangular, has nubs (122) on the sidewalls thereof, slots (124-125) receiving bone graft material (26) and is formed of radiolucent material.



P U 307 241 A2

SURGICAL PROSTHETIC IMPLANT

relates to the art of prosthetic transversely in a vertebral column s of the opposed faces of adjacent struts which are fused into the obtain a normal disc space between these devices are in the form of rigid ring the disc space in side-by-side being roughened surfaces facilitating the tissue.

is mounted endwise on a tool to be placed between the adjacent vertebrae, at will reclaim the normal disc space in remaining tissue of a collapsed Preferred plugs have barbs biting flae, slots for carrying bone, graft and leading ends facilitating insertion of vertebrae and are formed from a material.

out in my United States Patent No. 4,737,803, issued May 10, 1988, the leading cause of disc problems arises from rupture or degeneration of vertebral discs. Pain in the lower back (sciatica) is caused by pinched spinal nerve roots by damaged discs of vertebrae and low back pain is caused by the disc and the adverse effects of gravity on the body weight through a sole vertebral joint. Surgical treatment of the sciatic pain and lower back include the following:

The Ruptured Soft Disc

here removes the portion of the disc that pinches the spinal nerve and is generally relieving the sciatic leg pain but in most of the cases, there is a recurrence of pain. Over a period of time the disc gradually gives way due to the rupture and this loss of motion at the posterior facet joints of the spine, it incorrectly resulting in arthritic elements of the spinal segment. Nerve root compression due to bony stenosis (spinal stenosis) also develops. The recurring back pain from this source is a leading source of pain and disability.

Fusion With Posterior Fusion

Posterior fusion, creating bone growth along laminae, or postero-lateral fusion of transverse processes prevents motion of adjacent vertebrae but does not alter approximately 90% of the body weight distributed through degenerated discs. Furthermore, posterior fusion tends to overlap with leading to nerve root and spinal stenosis.

3.) Disc Excision With Anterior Interbody Fusion

Interbody fusion techniques, in which the soft disc is completely excised and replaced with either the patient's own bone (autologous bone) or with transplant banked bone (homologous bone) are generally successful if solid fusion can be obtained between adjacent vertebrae bodies. Unfortunately, the success rate has only been about 50%.

4.) Disc Excision With Posterior Lumbar Intervertebral Fusion (PLIF)

This procedure reconstructs the normal anatomic relationships between the bony and the neural structures and has many advantages. Weight bearing through a solid bony fusion mass between vertebral bodies relieves the mechanical pain of the traditional unstable degenerative disc and generally prevents long term disc collapse or further degenerative changes. The complete disc excision prevents recurrent herniation of the same degenerated disc.

However, this PLIF procedure has several serious disadvantages in that it is technically very difficult, and, therefore, not as successful or widely used as it might be. It entails large amounts of blood loss in a small deep hole causing physiological stress to the patient and psychological distress to the surgeon. Further, the use of autologous bone graft from the patient's own iliac crests extends the operation and creates a second painful operative site. Because it is difficult to obtain a large enough quantity of autogenous bone with sufficient strength, homologous bank bone is generally used.

Interbody bone grafting involves the problems of strength and that of bone incorporation. Strong cortex bone (the outer layer) is required as a strut in the interbody position to prevent collapse of the disc space while healing occurs. The surgeon has the unfortunate requirement of having to fashion the required struts with handheld tools during the operation and these cortex bone struts are not wide enough for optimum load bearing and they anchor themselves by healing process that occurs very slowly over a matter of years. Further, soft cancellous bone, which heals more reliably over a matter of 12 to 18 months, is also required for a traditional interbody fusion.

It is well understood in orthopaedic surgery, that grafted bone heals by a process called "creeping substitution" in which blood capillaries first grow into the grafted bone, the grafted bone is reabsorbed, and then new bone cells are laid down along the bony matrix of the graft. During the time that the structural bone grafts struts are being reabsorbed, motion must still be prevented in the involved segments and although a brace or cast is often used, the entire process has proven less reliable than desired. Homologous bank bone, being more "foreign", requires a much longer time to grow together and has a higher failure rate estimated at

plugs instead of being made of an inert metal, can be made of a radiolucent material, such as a plastic of the nylon, polycarbonate, polypropylene, polyacetal, polyethylene, and polysulfone type, preferably filled with glass or carbon fibers. These plastics can be injection molded, are light in weight, have great load carrying strength and provide improved x-ray visualisation of bone healing. Fiber reinforced plastics composed of such materials filled with glass or carbon fibers are also desirable. A preferred material is a polyether sulfone resin filled with glass and carbon fibers. Suitable carbon fiber composites are supplied under the tradename "VICTREX P.E.S." which is polyether sulfone filled with carbon fibers. Suitable graders are "4101 G.L.-30" which is a 30 percent fiber glass filled and "450 C.A.-30" which is a 30 percent carbon fiber filled. These materials are supplied from ICI Industries of Wilmington, Delaware. Carbon-carbon fiber plastics of the type sold by Fiber-Rite Corporation of Winona, Minnesota, are useful.

The invention will now be further described by way of examples with reference to the accompanying drawings, in which:-

Fig. 1 is a side elevational view of the lower portion of a human vertebral column with parts broken away and shown in section to illustrate prosthetic implants of this invention inserted between several of the lower vertebrae;

Fig. 2 is a posterior elevational view of a portion of FIGURE 1 taken along the line II-II of FIGURE 1.

Fig. 3 is a cross-sectional view with parts in elevation and broken away in section along the line III-III of FIGURE 2.

Fig. 4 is an enlarged fragmentary side elevational view with parts shown in vertical section illustrating the manner in which the implant receiving sites of adjacent vertebrae are prepared.

Fig. 5 is a view similar to FIGURE 4 illustrating the manner in which an implant is inserted in position on prepared sites of adjacent vertebrae.

Fig. 6 is a perspective view of one form of a prosthetic plug of this invention having a knurled periphery and showing the tool receiving recesses in an end thereof.

Fig. 7 is a perspective view of another form of implant plug of this invention having a pitted periphery.

FIG. 8 is a side elevational view with parts broken away and showing an axial section of a prosthetic plug of this invention with deflectable locking prongs on the periphery thereof.

FIG. 9 is a perspective view similar to FIGURE 6 illustrating a threaded periphery on the plug providing roughened surfaces.

FIG. 10 is a perspective view of a prosthetic plug of this invention with a resin coating thereof having radiating bristles.

FIG. 11 is a transverse sectional view along the line XI-XI of FIGURE 10.

FIG. 12 is a side-elevational view of the lower portion of a human vertebrae column with parts

broken away and shown in section to illustrate flat-sided rectangular prosthetic implant plugs or blocks of this invention inserted in rectangular grooves or channels in the opposed faces of adjacent vertebrae to support the vertebrae in place of the human disc therebetween which has been partially excised to remove damaged and herniated tissue.

FIG. 13 is a posterior elevational view of a portion of FIGURE 12 taken along the line XIII-XIII of FIGURE 12.

FIG. 14 is a transverse sectional view, with parts in elevation and broken away in section, along the line XIV-XIV of FIGURE 13.

FIG. 15 is an enlarged fragmentary side elevational view, with parts broken away and shown in vertical section, illustrating the manner in which a trial or gauge plug or block of this invention is inserted in position in the transverse rectangular slots of adjoining vertebrae to stretch the remaining interposed disc tissue connected to these vertebrae and to gauge the sites for receiving a proper sized permanent implant.

FIG. 16 is a plan view of a vertebrae disc with the interior pulp removed and the disc tissue partially excised to provide gaps or slots aligned with channels cut in the vertebrae to receive the plugs therethrough.

FIG. 17 is a perspective view of a smooth faced trial or gauge plug or block for use as shown in FIGURE 15.

FIG. 18 is a perspective view of a preferred form of permanent implant plug or block of this invention.

FIG. 19 is a longitudinal vertical sectional view of the plug of FIGURE 18 taken along the line XIX-XIX of FIGURE 18.

In FIGURES 1-5 the reference numeral 10 illustrates generally the lower portion of a human vertebral column with adjacent vertebrae supported on prosthetic implants of this invention or illustrating the manner in which sites are prepared for the implant and the manner in which an implant is inserted on the prepared sites.

In FIGURE 1, the vertebral column 10 shows the five lower vertebrae numbered 1-5. Adjacent vertebrae Nos. 2 and 3 and adjacent vertebrae Nos. 3 and 4 are separated by and supported on prosthetic implants 11 of this invention. Vertebrae Nos. 1 and 2 and vertebrae Nos. 4 and 5 are illustrated as supported on and separated by healthy or undamaged human discs 12 maintaining a disc space 13 between the adjoining vertebrae.

The natural human discs have been excised from between discs Nos. 2 and 3 and Nos. 3 and 4 with the disc spaces 14 being maintained by the implants 11. The opposed faces of adjoining vertebrae have prepared sites or channels 15 formed therein generally transversely of the axis of the column 10 to snugly receive cylindrical opposite faces of the implants 11. These transverse sites 15 are sufficiently wide and deep to span the central soft cancellous bone and include the hard cortex bone of the adjacent vertebrae. However, the sites have

blind ends 16 to bottom the implants 11.

As shown in FIGURES 2 and 3, the implants 11 are in the form of a pair of side-by-side cylindrical plugs inserted endwise on the transverse sites 15 which are fragmental cylindrical to receive and mate with opposite faces of these plugs.

The soft cancellous bone of the vertebrae is illustrated at 17 in FIGURE 3 and is surrounded by the hard cortex bone 18 of the vertebrae No. 3. The prepared sites 15 include portions of this hard cortex so that the implants 11 span the softer cancellous bone 17 and rest on the hard cortex bone 18.

The plugs 11 fit snugly in the prepared sites 15 and are bottomed on the blind ends 16 of these sites.

The plugs are rigid, preferably solid, and have roughened surfaces forming extensive anchor points or pores for bone ingrowth from the adjoining vertebrae. They may be made of an inert metal, such as stainless steel, cobalt-chromium-molybdenum alloys, titanium, and the like. They may have many different shapes and peripheral surface configurations. They have an end face with tool receiving recesses so as to be mounted on the tool for insertion on the prepared site and for removal of the tool without disturbing the mounting. These tool receiving recesses are illustrated in the form of an internally threaded circular hole 19 tapped into one end face 11a of the plug. A radial slot 20 diametrically intersecting the tapped hole 19 is also provided in the end face 11a thus forming wings radiating from the tapped hole 19. The hole 19 extends axially forward from the end face 11a for a relatively short distance sufficient to provide a number of thread turns to be firmly anchored on the threaded end of an insertion tool.

As shown in FIGURE 4, the sites 15 of the adjoining vertebrae Nos. 2 and 3 are easily prepared by a rotary drill or burr 21 slidable through a drill guard 22 with teeth or prongs 23 penetrating and anchored in the posterior side of both vertebrae. The drill is advanced through the sleeve 22 through the posterior sides of the vertebrae, but the drilling operation stops short of the anterior sides of these vertebrae so as to provide the blind ends 16 on the prepared sites.

While the sites 15 are easily prepared with the drilling apparatus illustrated in FIGURE 4 it should be understood that sites of different shapes can be prepared with a mortise cutter or chisel shaped to conform with the shape of the implant to be inserted.

As shown in FIGURE 5 implant 11 is easily inserted on the prepared sites 15 from the posterior side of the vertebrae Nos. 2 and 3 by means of a tool assembly 24 having a stem 25 with a threaded end 26 mating with the tapped hole 19 in the end face 11a of the implant 11 and mounted in an easily grasped handle 27 at the opposite end. A sleeve 28 is slidably mounted on the stem 25 and has diametrically opposite keys or lugs on its forward end fitting the radial slot 20. A knurled head 30 is provided on the opposite end of the sleeve.

The tool 24 with the sleeve 28 retracted on the stem 25 to expose the threaded end 26 of the stem is threaded into the tapped hole 19 and bottomed on

the blind end thereof. The plug 11 is thus firmly mounted on the tool and the tool is manipulated to seat the plug on the prepared sites to be bottomed on the blind ends 16 of the sites 15. After positioning of the plug on the sites, the sleeve 28 is advanced on the stem 25 to bottom the prongs 29 in the slot 20 and the stem is unthreaded with the knurled head 30 of the sleeve being firmly held to prevent rotation of the sleeve and plug.

The plug 11 is illustrated in detail in FIGURE 6 as having a solid cylindrical rod configuration with its circular end face 11a having the internally headed hole 19 extends axially inward therefrom and with the diametrically intersecting radial slot 20 providing the wings for receiving the prongs 29 of the sleeve 28. The cylindrical rod 11 has a knurled roughened peripheral surface 11b forming pyramid-like pits 11c for facilitating bone ingrowth. The plug is dimensioned to snugly fit on the prepared sites between the posterior and anterior side of the vertebrae. Its dimensions may vary widely to suit conditions and plug sizes of about 5/8" in diameter and about 1" in length are useful. The tapered hole 19 in the end face 11a of such a plug need only be about 1/8" in diameter and 1/4" in depth. The slot should terminate short of the periphery and need only be about 1/8" deep.

Another suitable form of prosthetic implant of this invention is illustrated in FIGURE 7 where the device 31 has a square rectangular shape with an end face 31a having the tapped hole 19 and groove or slot 20. The device 31 has a pitted periphery 31b forming a myriad of small pores to facilitate bone ingrowth.

Another form of prosthetic device 32 is illustrated in FIGURE 8 in the form of a cylindrical plug 32 with an end face 32a containing the tapped hole 19 and slot 20. The periphery of the cylindrical plug has longitudinally spaced circular ribs 32b. These ribs form dish-like prongs or barbs tilted toward the threaded end of the plug so that they will deflect to slide into the prepared sites but will bite into the bone to resist retraction from the sites. As illustrated the ribs have convex leading faces 32c and concave trailing faces 32d. Such configuration assists deflection when the plug is pushed into position but will spring back to resist reverse retraction or rotation. If desired the ribs can be axially slotted to provide a myriad of barbs.

In the embodiment 33 of FIGURE 9 the implant is in the form of a solid cylindrical rod with an end face 33a containing the tapered hole 19 and slot 20 and with the cylindrical periphery being externally threaded as illustrated at 33b. The thread will advance the plug into the prepared sites when the plug is rotated in a clockwise direction. The threads can have sharp edges to bite into the bone structure.

The implant plug 34 of FIGURES 10 and 11 has the same end face 34a as the other plugs with the tapped hole 19 and slot 20, however, it has a solid rigid circular rod core 34b with a polymeric resin cover 34c with the peripheral surface of the cover having upright projecting bristles 34d. These bristles form extended surfaces facilitating bone ingrowth.

Many other types of rough or irregular surfaces

can be provided on the devices of this invention including porous metal coatings composed of metal balls and beads sintered on a rigid metal substrate as further disclosed in the aforesaid Patent No. 4,743,256.

The prosthetic implants are shown on the drawings as mounted in side-by-side parallel relation forming a pair of struts which maintain the disc space being snugly seated on hard cortex bone to carry the load. These implants have surfaces facilitating rapid bone ingrowth which will fuse the implants to the adjacent vertebrae in a relatively short growth period.

In FIGURES 12-14, the reference numeral 100 illustrates generally the lower portion of a human vertebral column with adjacent vertebrae supported on prosthetic implant blocks or plugs 111 of this invention.

FIG. 15 shows the manner in which adjacent vertebrae are spread apart to stretch collapsed intervening disc tissue as a gauge or trial blocks of this invention is inserted laterally into transverse rectangular slots of adjoining vertebrae.

In FIGURE 12, the vertebral column 100 shows the five lower vertebrae Nos. 1-5. Adjacent vertebrae Nos. 2 and 3 and adjacent vertebrae Nos. 3 and 4 are separated by and supported on the prosthetic implant blocks or plugs 111 of this invention. Vertebrae Nos. 1 and 2 and vertebrae Nos. 4 and 5 are illustrated as supported on and separated by healthy or undamaged human discs 112 maintaining a normal disc space 113 between the adjoining vertebrae.

Damaged portions of the natural human discs 112 have been excised from the vertebrae Nos. 2 and 3 and Nos. 3 and 4 with the disc spaces 114 being maintained by the implant blocks or plugs 111. It is preferred to retain as much as possible of the healthy annulus tissue of the discs 112 between the vertebrae so that the remaining disc tissue 112a will at least partially surround the implants and will be held under tension by these implants. However, some of the remaining annulus disc tissue may have to be excised to open up spaces for the implant plugs 111.

The opposed faces of adjoining vertebrae have aligned flat-sided rectangular channels or grooves 115 cut therein transversely of the axis of column 100 first snugly receive test blocks or plugs of this invention for determining the proper sizes for the permanent implants 111. These transverse channels 115 are sufficiently wide and deep to span the central soft cancellous bone and include the hard cortex bone of the adjacent vertebrae. The undamaged human disc tissue 112a remaining between the vertebrae is also cut or trimmed to receive the implants 111 so that as much healthy annulus fibrous tissue as is available will surround the implants.

The preferred flat-sided rectangular channels 115 have blind ends 116 to be abutted by the implants 111.

As shown in FIGURES 13 and 14, the implants 111 are in the form of a pair of side-by-side rectangular plugs inserted endwise into the transverse channels 115. These channels have flat bottoms and sidewalls

to snugly embrace the top and bottom ends and side faces of the rectangular plugs. The soft cancellous bone of the vertebrae is illustrated at 117 and the bone 14 and is surrounded by the hard cortex bone 118. The channels 115 include portions of the hard cortex bone so that the implants 111 span the softer cancellous bone and rest on the hard cortex bone 118.

The channels 115 can be formed by a mortise cutting chisel tool and in the event disclosed at 117a blocks the paths for the plugs 111, tissue can be trimmed or spread apart to open up the paths.

The implant plugs of blocks 111, as shown in FIGURE 18 and 19, are rigid, inert, solid, flat-sided rectangles, higher than wide and longer than high. They are used in cooperation with trial or gauge blocks, such as 119, shown in FIGURE 17. These blocks 119 have flat, smooth sides and ends, flat top and bottoms 119a, flat sides 119b, a flat front wall 119c, and a flat back end wall 119d. The front wall 119c is beveled to a reduced height 119e and surrounded by flat-sided tapered walls 119f. The rounded corners 119f.

The back end wall 119d has an interrupt blind axial hole 119g at the center of the end.

The gauge blocks 119, in typical surgical operations, will have a length of about 25 mm, a width of about 11 mm and will vary in height from say 15 to 17 mm, although it should be understood that these parameters may vary greatly and may depend on the size of the spinal column of the recipient. The top and 119e are preferably about 30 degrees. The rounded corners 119f of the bevels eliminate sharp corners between the top, bottom and sides of the bevelled faces.

As shown in FIGURE 15, a trial or gauge block 119 is selected for force-fitting into the channels 115 while mounted on a tool 120 threaded into the block 119g. The beveled front end 119c of the block 119 will pass through any portion of the disc tissue 112a covering the entrance mouths of the channels 115, by either cutting holes through the remaining tissue 112a or by spreading apart the fibers of the disc 112a. The gauge blocks 119.

As shown in FIGURE 16, the remaining healthy disc tissue 112a of a disc 112 between the channel cut vertebrae is trimmed to open up slots 121 permitting access of the gauge blocks 119 to the channels 115. These slots register with the channels 115 and can have open front ends 121a and blind back ends 121b. It is preferred to remove the nucleus pulposus from the damaged disc 112 leaving an annulus of fibrous tissue connecting the adjoining vertebrae and surrounding the inserted blocks.

A proper fitting gauge block 119 is selected by trial and error insertions into the channel cut vertebrae. These blocks are smooth faced and can be removed even when tightly fitted in the channels 115.

As shown in FIGURE 15, a gauge block 119, threaded on the end of an insertion tool 120 is selected to have a height greater than the height between the bottoms of opposed channels 115. Then, when this block is pushed through the open

ends of the aligned channels 115, the beveled nose 119c will engage the bottoms of these channels forcing them apart as the block is pushed into the channels thereby stretching any disc tissue 112a still connecting the vertebrae. The block is pushed against the blind ends 116 of the channels and the tension on the disc fibers is determined. When a block 119 of sufficient size to properly load the disc tissue and to fit snugly in the channel, is located, a permanent implant plug 111 of a size just slightly greater than the gauge block is selected. Such a permanent plug is then threaded on the end of a tool 120, the gauge block 119 is withdrawn, and the permanent implant 111 on the tool is forced into a position in the channels 115.

A preferred permanent implant block or plug 111 is illustrated in FIGURES 18 and 19. This plug has about the same flat side dimensions as the selected gauge block, but has projected from these flat top, bottom and sidewalls, a pattern of raised annular nubs 122 providing a roughened surface, biting into and gripping the bottoms and sidewalls of the rectangular channels 115. These nubs are separated by annular grooves 123 and longitudinal channels 123a so that each nub 122 will have a flat vertical back wall 122a, a pair of flat vertical sidewalls 122b and an inclined front face 122c.

The plug 111 has the same reduced nose 111a surrounded by the same beveled sidewalls 111b as the nose 119c and beveled sidewall 119e of the gauge block 119. In addition a vertical back wall 111c is the same as the back wall 119d and contains the same internally threaded hole 111d as the back wall 119d of the gauge block 119.

Further, the implant plug 111 has a vertical slot 124 therethrough connecting the tops and bottoms of the plug. This vertical slot 124 is rectangular, has a width about 1/3 the width of the block and a length extending close to the front and rear ends of the plug.

This slot 124 is intersected centrally by a horizontal through slot 125. It will be understood that, alternatively, the block 111 may have only a single horizontal or vertical slot.

The slots 124 and 125 provide cavities in the block or plug 11 which are filled with strips of bone implant 125 preferably harvested from the pelvis bone of the recipient. The bone material housed in the implant plugs 111 will soon grow out of the grooves or channels 124 and 125 into the radial and longitudinal channels between the nubs 122 surrounding the plugs 111 and will then grow into the bone tissue of the adjoining vertebrae.

When the implant plug is pushed into its seated position between the vertebrae, the inclined front faces of the nubs 122 will accommodate the forward moving of the plug to the blind ends 116 of the channels 115, but the sharp apexes of the nubs will prevent retraction of the plugs since they will bite into the vertebrae bone. Therefore, once the plugs are seated in proper position, they will not shift from this position.

It is preferred that the height of the plugs 111 will be sufficient to maintain a tension load of about 20 to 30 pounds on the disc tissue. Such a tension load

not only pulls the vertebrae tightly against the plugs, but also accelerates bone ingrowth.

The preferred prosthesis plugs or blocks 111 of this invention not only facilitates and simplify the surgical procedure but also accelerate interbody fusion of the vertebrae with the plug. The roughened surfaces provided by the nubs thus serve a multiple purpose of anchoring into the vertebrae, and providing channels for bone ingrowth.

Claims

1. A prosthesis for a vertebral column (10,100) transverse prepared sites (15,115) opposed faces of adjoining vertebrae (2-3, 3-4) and a disc space (14,114) between the adjoining vertebrae which is characterised by side-by-side rigid plugs (11,31-34,111) sized and shaped to form transverse struts bottomed on the prepared sites of adjoining vertebrae and maintaining a desired disc space between said adjoining vertebrae, each plug having a roughened surface (11b,31b,32b,34,122) interlocking with said prepared sites to facilitate bone ingrowth from the vertebrae, and each plug having an end face with tool receiving means extending internally of the plug (19,111d) for fixedly mounting the plug endwise on a tool (24,120) to facilitate endwise insertion of the plug and on the prepared sites.

2. A prosthesis as claimed in claim 1, characterised in that the plug roughened surfaces are barbs (32,122) radiating from the rigid metal and having leading faces (32c,122c) sloping toward the tool receiving end of the plug to bite into the vertebrae and provide extended areas receiving bone ingrowth.

3. A prosthesis as claimed in claim 1 or 2, characterised in that the tool receiving means is an internally threaded hole (19,111d) in the end face of the plug for threaded engagement with the end of the tool.

4. A prosthesis as claimed in claim 3, characterised by including a radial slot (20) in the end face radiating from the internally threaded hole.

5. A prosthesis as claimed in any one of the preceding claims, characterised in that the plug is a solid rod (11,31-34,111) having a length sufficient to engage and hard cortex bone (18,118) of the vertebrae and span the soft cancellous bone (17,117) of the vertebrae without projecting beyond the cortex bone.

6. A prosthesis as claimed in any one of the preceding claims, characterised in that the plug has at least one slot (124,125) therethrough adapted to receive bone graft material (126).

7. A prosthetic device adapted for fusing together adjoining vertebrae (2-3,3-4) with spaced opposed faces on opposite sides of a damaged collapsed vertebrae disc having tissue (112a) connecting the adjoining verte-

vertebrae bodies, said opposed faces of the vertebral bodies having aligned transverse channels (15,115) cut therein; and said disc tissue having openings (121a) therethrough aligned with the channels, characterised in that said device comprises a rigid inert plug (11,31-34,111) having a greater height than the damaged disc space between the bottoms of the aligned channels for force fit into the channels to stretch the disc tissue to maintain the original undamaged disc space, and surfaces (11b,31b,32b,34d,122) on said plug for engaging surfaces of the channels (15,115) to facilitate ingrowth of bone tissues from the vertebral bodies bottomed in the channels to fuse the bodies together in fixed relation.

8. A prosthetic or prosthetic device as claimed in any one of the preceding claims, characterised in that the plug (111) is formed from a radiolucent material.

9. A method of fusing together adjoining vertebral bodies (2-3,3-4) having spaced opposed faces with a disc space (14,114) therebetween while maintaining said disc space characterised by comprising mounting an inert rigid plug (11,31-34,111) with roughened surfaces (11b,31b,32b,34d,122) on the end of a tool (24,120), cutting opposed transverse channels (15,115) in said spaced opposed faces

inwardly from adjoining sides of the vertebral bodies and terminating short of the opposite sides of the vertebral bodies (16,116), inserting the plug endwise on the tool into said channels to form a strut supporting the vertebral bodies, removing the tool from the plug without moving the plug, and facilitating bone ingrowth from the vertebral bodies around the roughened surfaces in bonded relation thereto.

10. A method of using a prosthetic or prosthetic device as claimed in any one of the claims 1 to 8, to fuse together spaced adjacent vertebral bodies connected by collapsed damaged intervening disc tissues which is characterised by cutting aligned transverse channels (15,115) into the adjoining faces of the spaced vertebral bodies, providing an opening (121a) into the disc tissue (112a) communicating with the aligned channels, forcing a rigid inert plug (11,31-34,111) into the channels and causing the disc tissue to spread the adjoining vertebral bodies apart and stretch the disc tissue to maintain the disc space of the undamaged side, and providing irregular surfaces (11b,31b,32b,34d,122) on said plug to grip the surfaces of the channels and facilitate bone ingrowth to fuse the plug to the vertebral body.

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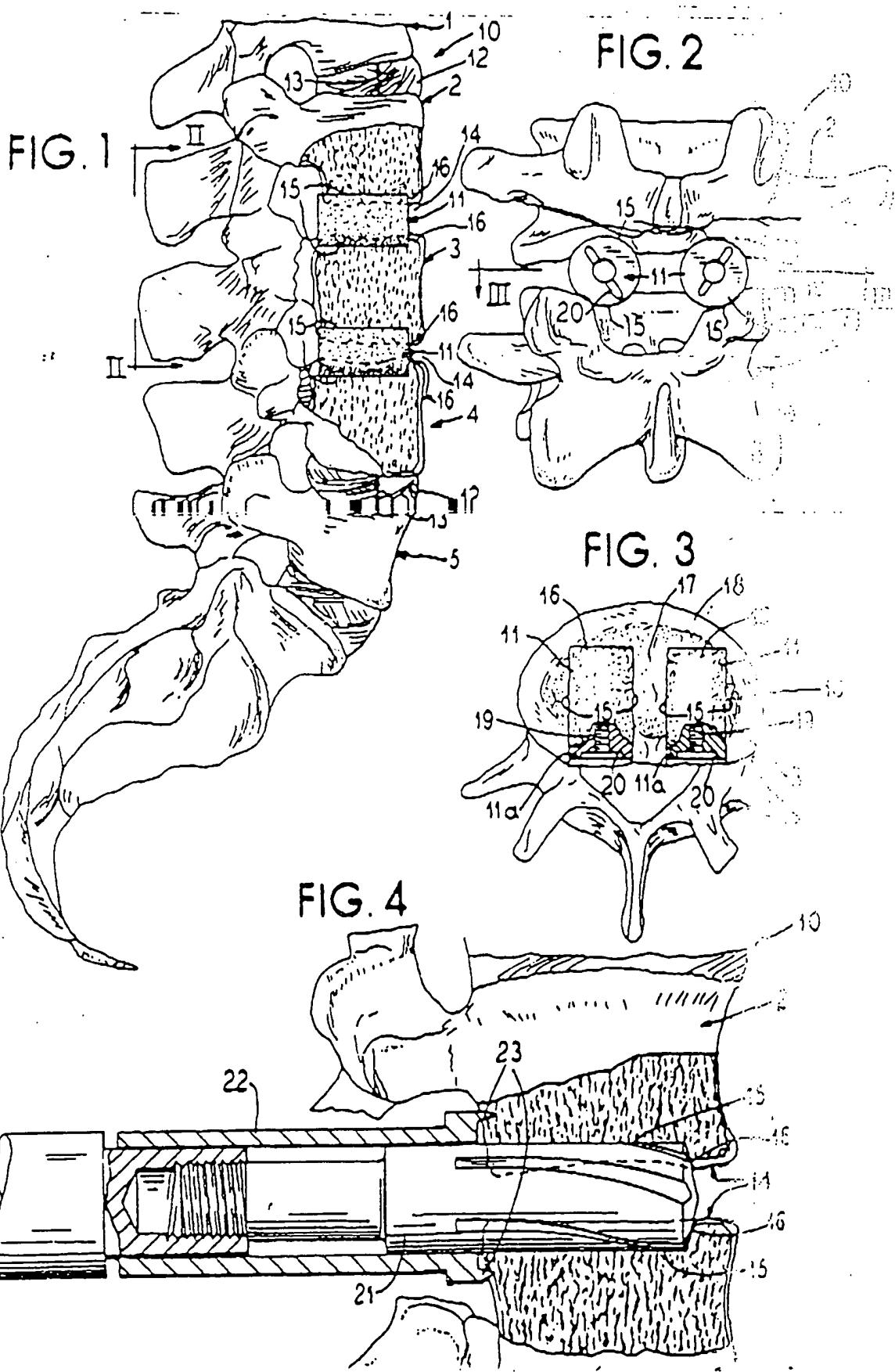


FIG. 5

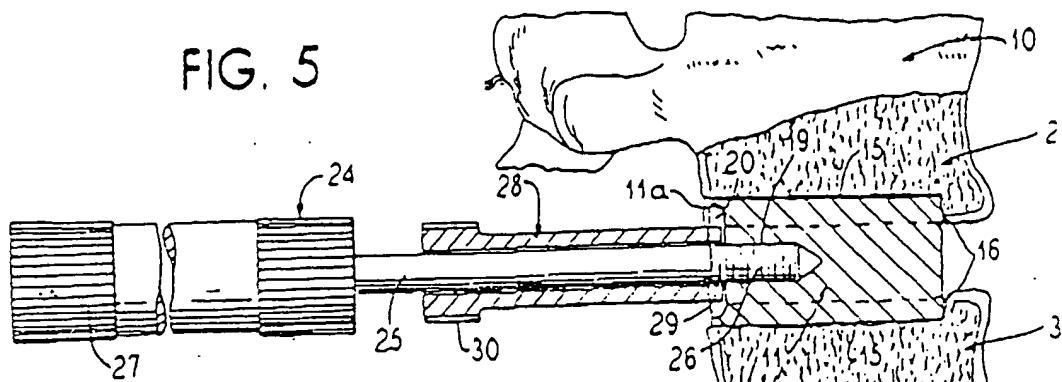


FIG. 6

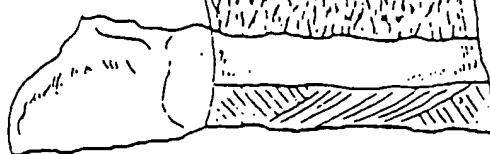


FIG. 7

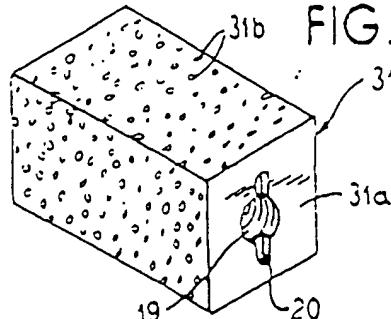


FIG. 8

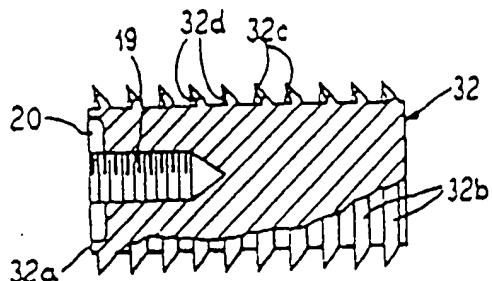


FIG. 9

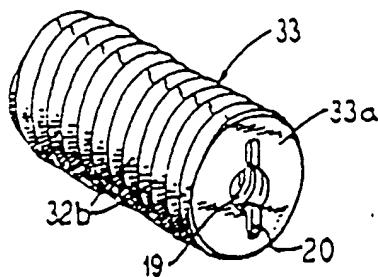


FIG. 10

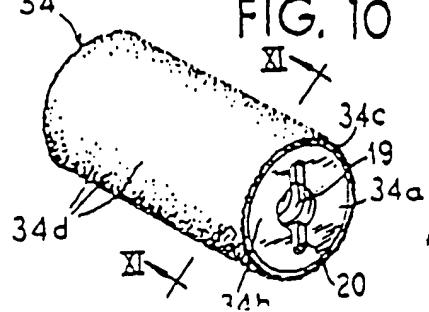


FIG. 11

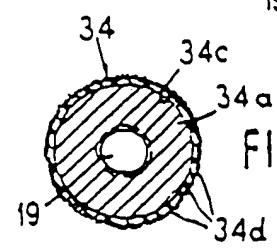


FIG. 12

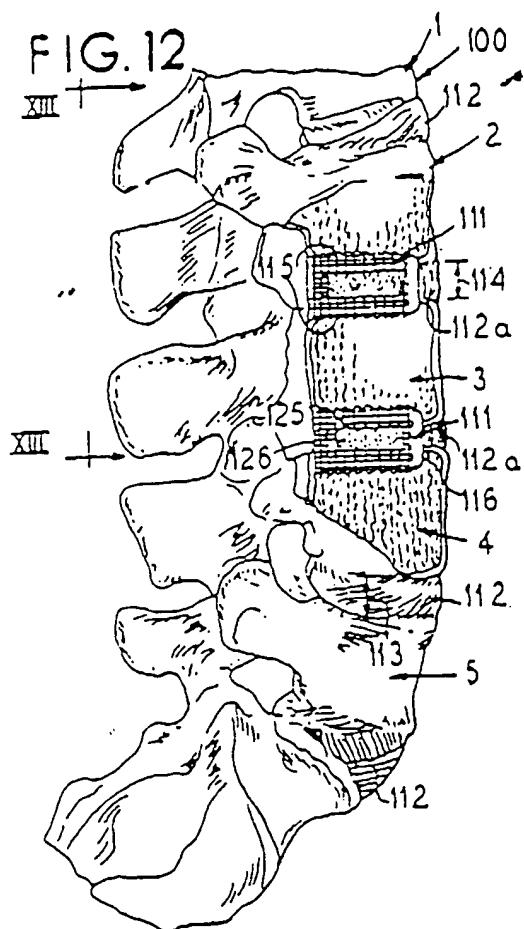


FIG.13

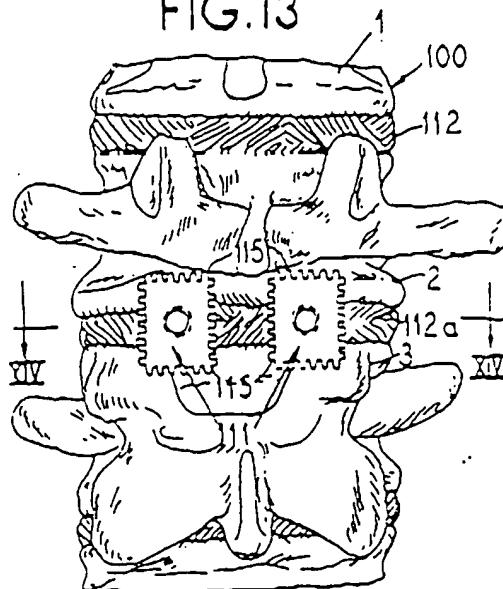


FIG. 14

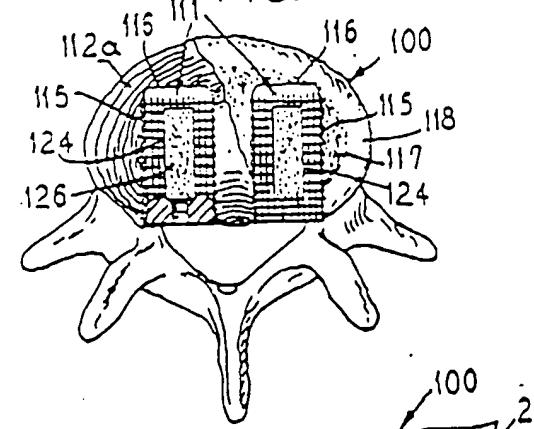


FIG. 15

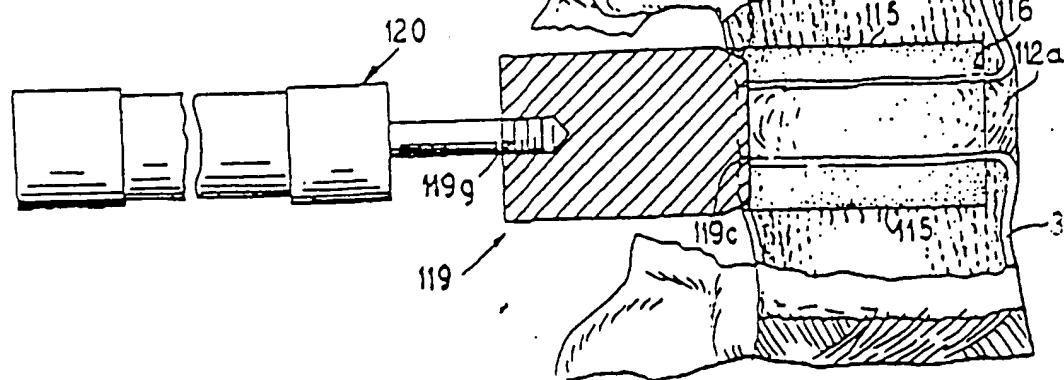


FIG. 16

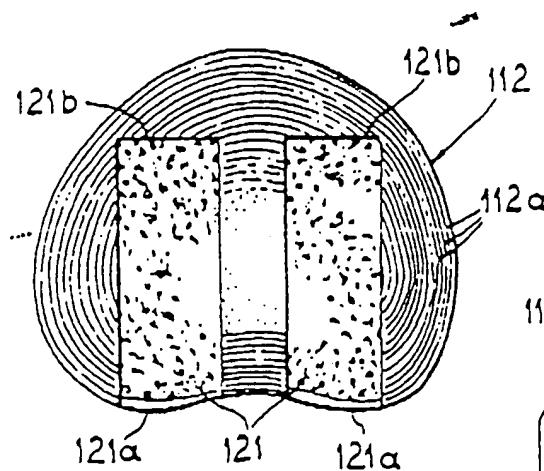


FIG. 17

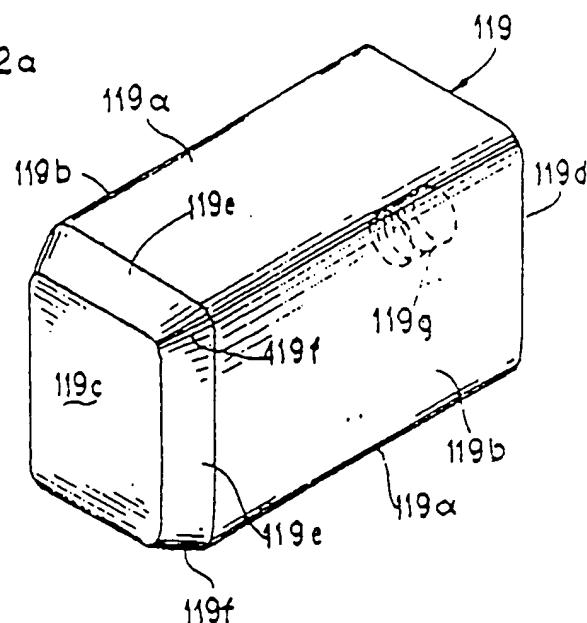


FIG. 18

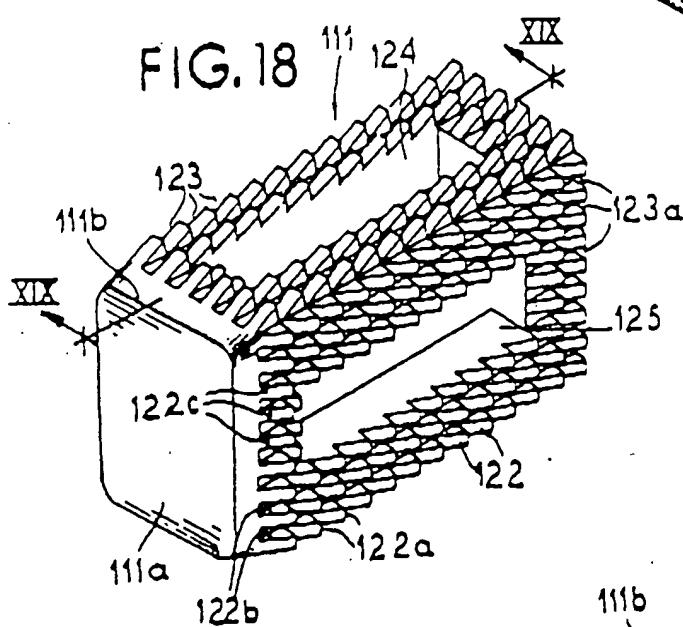
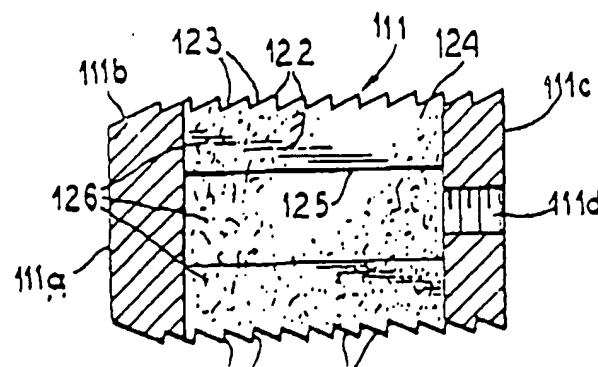


FIG. 19





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which under Rule 45 of the European Patent Convention
shall be considered, for the purposes of subsequent
proceedings, as the European search report

Application number
EP 0303371

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 17)
X	<u>DE-A-3505567</u> (VICH) * page 6, lines 3-22; claims 1-3; figures 1,2 *	1,3,5,7	A61B17/50 A61M2/14
A	<u>EP-A-0042271</u> (KUNTZ) * page 10, line 25 - page 12, line 11- page 13, lines 10-19; page 24, lines 27-35; claims 4,5,7,9; figures 1-3,13-15	1-3,7	
A	<u>US-A-4501269</u> (BAGBY) * column 3, lines 27-57; claim 1; figures 1-5 *	1,3,7	

TECHNICAL FIELDS
SEARCHED (Int. Cl.)

A61B17/00
A61M2/14

INCOMPLETE SEARCH

The Search Division considers that the present European patent application does not comply with the provisions of the European Patent Convention to such an extent that it is not possible to carry out a meaningful search into the state of the art on the basis of some of the claims.

Claims searched completely: 1-8

Claims searched incompletely:

Claims not searched: 9,10

Reason for the limitation of the search: Method for treatment of the human
or animal body by surgery Article 52(4)
EPC

Place of search	Date of completion of the search	Examiner
Berlin	13.02.1989	MORSE
CATEGORY OF CITED DOCUMENTS		
X : particularly relevant if taken alone	T : theory or principle underlying the invention	
Y : particularly relevant if combined with another document of the same category	E : earlier patent document, but published on, or after the filing date	
A : technological background	D : document cited in the application	
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